CARDIAC ARREST!

Advanced Cardiac Life Support
Simulation Program

Atari BASIC   48K RAM

Do NOT remove manual from
OREM COMMUNITY HOSPITAL

1.

First program manual,
kept in ER at Atari
computer for RNs
and paramedics during
testing/improvement
phase

CARDIAC ARREST!

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REQUIRES: 48K RAM, BASIC Cartridge.

INTRODUCTION: In this computer simulation of advanced cardiac resuscitation, you are the emergency specialist. When presented with a patient, you carefully read the history, then give orders to the resuscitation team members. Don't jump to any conclusions because you think you've seen the same patient before--no patient will ever be exactly the same twice. Several patients with radically different problems have the same history in order to keep you honest. The team members will automatically start CPR when it is necessary--you use your brains to get the patient going again.

This is not a program for kiddies. The patients are real patients; the drugs you use are real drugs. Proper use of drugs and proceedures will save a life--inappropriate use of a drug or therapy may end any chance the patient had of surviving. With the help of the manual and some practice, a person who knows nothing about medicine can soon begin to "save lives." The more difficult patients would present a challenge even to the emergency specialist.

My goal has been to create a simulation which is realistic, flexible, and which allows use of regular English in giving orders, yet which will run on a 48K computer. Some compromises had to be made to accomplish all the goals of the program, but I think you will find that it is useful in learning or reviewing drug uses and doses.

The program is designed to allow someone who is already familiar with advanced cardiac resuscitation to proceed after minimal orientation. Reading this first section may be all that you will need. Someone who knows little about medicine can still learn to save patients with the help of the manual--but be prepared to work your brains. After all, learning to play the role of a doctor requires a little more exercize of grey matter than learning to shoot down alien spacecraft. Just skip over the big words in this first section as you skim through, then struggle through the manual. You might want to borrow some medical books if you plan to get serious.

HOW DOES THE PROGRAM WORK? As the program begins, a patient file is pulled from the disk. This file contains many pieces of information about the patient: history, hematocrit, total blood volume, blood glucose, potassium, calcium, sensitivity to oxygen lack, amount of heart damage, cardiac reserve, etc. The program takes all these factors and calculates how irritable the heart is, how strongly the heart can contract, how much conduction blockage there is,

etc. It then calculates a rhythm, rate, blood pressure, respiratory status, and neurological status. (Yes, it's complicated) This is NOT a knee-jerk type program. You may do the right thing, but because of the patient's underlying condition, the next screen may show him to be in ventricular fibrillation. Use drugs and proceedures that are recommended, make use of the lab, and you'll do all right.

Virtually every cycle of the program, disk files must be read into the computer. The program also writes onto the disk. DO NOT WRITE-PROTECT the disk, and do not remove it while using the simulation, or the program will crash and you'll have to start over.

Each cycle (new screen) in the program ticks off one minute of time against the patient. Each "minute" of the resuscitation, you are shown a printout of the EKG as it would appear on the monitor screen. In the text window at the bottom, you see the time (pay attention to it), the heart rate, the pulse character, the blood pressure, the respiratory status and neurological status. Occasionally the recording clerk may have a comment for you. You then give your orders.

As resuscitation progresses, the computer updates the patient's status. It lowers the blood pH, adds to the accumulated cardiac and brain damage, and recalculates the factors which affect the heart. At certain points, it checks to see whether you are making any basic errors. On certain more complicated patients, some of these problems are hard to avoid.

Drug effects are calculated on a dose per kilogram basis. Of course, liberal side effects are included. Because the drug effects are calculated on basic parameters, you will definitely hurt your patient by using an inappropriate drug. Twenty cycles later, the unneeded drug will still be haunting you.

After fifteen cycles, the program will allow you to transfer the patient. The patient should have a good blood pressure and rhythm when you order the transfer. After 39 cycles, or when the patient is absolutely non-salvageable, the program cuts off. When you transfer (or the computer interrupts), you are given an outcome for the patient. Unlike real life, every patient in this game can be saved (but some will have a little brain damage no matter how well you do). How close your patient comes to a functional human being is your "score." The computer then informs you of any basic errors it detected, and gives you a chance to try the same patient again. It does NOT give you the "answer" to successful resuscitation--you just have to try again. After all, dead men tell no tales.

You can create your own "custom" patients through the

custom patient menu. On the 48K disk, boot the reverse side for the custom patients. The program is fairly self-explanatory. There is no guarantee that you will be able to resuscitate your custom patient if you make him too sick.

ORDERS: You may order drugs, defibrillation, lab tests, or proceedures (intubate, start IV, etc), using regular English. Be careful that the order does not become too complex, or the computer may do something that you did not intend. The computer scans for one act, one drug, one dose, one route (intravenous vs. endotrachael, etc), one units (ampule vs. milligrams, etc), and one adjective (pediatric vs. adult strength) per order. If more than one word of any category is entered, the computer will act on only the LAST word, ignoring the first. For drips (infusions), simply order the infusion, then the computer will prepare a standard solution and ask you for the dose or rate of infusion.

Keep the order as simple as possible, one order at a time. Use uppercase letters only. If you do not specify a route, it will be assumed that you want the drug given IV. Each order (other than simple questions: see below) will cost you one minute of resuscitation time. This forces you to determine priorities. Doses MUST be given in NUMBERS, not words. You must leave a space between every word, and between the dose and the units. Extra words in the order will make the computer take longer to decide what you wanted.

EXAMPLES:

Acceptable orders:
ATROPINE .5 MG
OBSERVE 10 MINUTES
RECTAL TEMPERATURE
DEFIBRILLATE 200 JOULES
ELECTROLYTES
SALINE INFUSION
.3 CC EPI BY VEIN
DRAW ABG
DEXTROSE 1 AMP
TRANSFUSE 2 UNITS PRBC
WARM NASOGASTRIC LAVAGE
EPI 1 AMP ENDOTRACHEALLY
START AN IV, PLEASE
INJECT 1 MG EPINEPHRINE
HANG ISUPREL INFUSION
DOPAMINE DRIP
BICARB 25 CC IV
NARCAN 2 PEDIATRIC AMPULES
PLACE ENDOTRACHEAL TUBE
SHOCK THE POOR DEAD GUY, 400 WATTS

Incorrect orders:
CALCIUM 5 CC OF 10% SOLUTION (contains more than one numerical value)
ONE AMP EPI (dose not in numbers: order "1 AMP EPI")
EPINEPHRINE 3CC (no space between dose and units)
GIVE 1 AMP EPI THEN DEFIBRILLATE (two orders)
2 AMPS ISUPREL IN 500 CC RUN AT 20 DROPS PER MINUTE (just order ISUPREL DRIP)
LIDOCAINE 75 MG THEN HANG DRIP (two orders)

You may also ask questions of the recording clerk. These questions do not "cost" you any time.

EXAMPLES:
WHEN WAS THE LAST BICARB
HOW LONG UNTIL LYTES BACK
HOW LONG SINCE LIDOCAINE BOLUS

If you need to review what you have done so far, you may order CHART or FLOWSHEET. This shows you minute by minute what orders you have given. It´s a good idea to look at this when the case seems complex. The computer assumes that it takes one minute for you to review the flowsheet.

The program has some features to try to head off errors. This will prevent the computer from killing your patient just because you ordered something a little differently. If your "reasonable" order has the computer hissing at you, simplify it down to the bare essence. Check your spelling. If all else fails, read the rest of the manual.

What can´t the program do? Any drug (such as steroids) which takes a long time to have an effect has been eliminated in order to save time and computer memory. A couple of drugs must be ordered in a specific way because of the way the "intelligence" in the program works. You will find these precautions discussed in the drug listing. Because the intracardiac route is hazardous and rarely used, you are not allowed to use it. A pacemaker is not allowed, either.

You are allowed only a routine IV. Cutdowns and subclavians will be ignored by the computer. Special proceedures are also not allowed (no burr holes in the ER, sorry).

Ready to start? If you are ACLS certified, you can start right now. However, you might want to glance through the order option list so that you have an idea of what drugs and proceedures the computer can accept. If you are a beginner, you´d better read the manual twice first.

If you are just learning cardiac life support, you can begin by following the diagram "A SIMPLIFIED APPROACH." It is loosely based on the current American Heart Association´s

standards (which may change at any minute). Or, after identifying the rhythm, you can look up the suspected problem in the listing "SOME SPECIFIC PROBLEMS." You can look up the treatment for most specific problems (such as hypotension or coma), or use the plan in "A SIMPLIFIED APPROACH" as your guide. Remember, "A SIMPLIFIED APPROACH" is merely an outline sketch of the sequence of treatments for true cardiac arrest. It may not apply to every patient on the disk.

Look up and read about each drug you plan to use in the order listing. Make sure you are using it for valid reason. Reasons for using a drug are listed after the word "Indications:" in each drug listing. Good luck.

A FOOTNOTE FOR PURISTS:

The program does not exactly duplicate real life. There are three reasons for this, which you must either accept or ask for your money back. First, a home computer simply does not have enough memory to follow every single variable and "what if." If you play around, throwing in every drug you can think of, you might see an effect which has no relation to real life. Second, because my wife put the computer in the fish pond after I had spent 15,000 hours "fine tuning" this program, there are undoubtedly some quirks that I haven't found yet. And third, real life is too boring. Certain factors in the program have been deliberately exaggerated for educational purposes. So things happen faster and more dramatically than in real life.

One should never try to diagnose such things as electrolyte abnormality and heart attack from the monitor screen in real life. You need a twelve-lead EKG. But in this simulation you have no choice.

Certain relationships are only approximate. If you get out the blood gas computer to see if the values for pH, bicarb, and carbon dioxide are perfectly related, you will find that they are close, but not perfect.

A BASIC UNDERSTANDING OF CARDIAC ARREST

INTRODUCTION: The heart is a pump. If it is pumping enough blood around, then (assuming there is no other problem such as a stroke, narcotics, etc) the heart's owner is alive. If the heart does not pump enough blood, the person's organs become damaged. If the lack of blood flow lasts long enough, the damage to the brain (and the heart, too) becomes permanent.

If there is no blood flow at all, we call this cardiac arrest. In cardiac arrest, there is no pulse (and therefore no blood pressure), and the patient is unconscious and not breathing. Cardiac arrest does not mean one specific rhythm (like ventricular fibrillation or asystole), it means that the heart is not pumping well enough to cause a pulse.

If there is a little blood flow, but not enough to prevent tissue damage, we call it "shock." Shock is diagnosed by a low blood pressure (hypotension). A pulse can be felt. The tissue damage does not occur very quickly with shock compared to cardiac arrest, because the organs are getting SOME blood flow. It is necessary, however, to get the blood pressure back to normal as soon as possible.

After cardiac arrest, the organs take a little while to get going again. The patient will take a few minutes to wake up. In this simulation, observe at least 10 minutes after the patient gets a pulse to see how much he will recover.

WHY IS THE PATIENT DYING? There are several reasons why the heart might not pump enough blood. For the purposes of this computer simulation, these reasons are 1) abnormal heart rhythm, 2) too little blood to pump around, 3) too much heart damage (severe heart attack) for the heart to pump effectively, 4) effects of drugs on the heart and blood vessels, and 5) abnormalities of blood chemistry or body temperature which affect the heart's function.

1) Abnormal rhythm: The heart has an electrical system which makes it pump just over once a second. This pacing system can become out-of-order because of heart attack, drugs, cold, or abnormal blood chemistry. A pace which is too fast or one which is too slow can prevent the heart muscle from pumping blood effectively. If an abnormal rhythm results in low blood pressure, it needs to be treated. If the blood pressure is O.K., then do not treat the rhythm itself, but consider what problem might be developing that the rhythm disturbance is warning you about.

2) Too little blood: If the blood volume is very low, then the heart cannot get blood to vital organs even if it is working perfectly. The blood volume may be decreased because of bleeding, or may be decreased because of dehydration.

Fluid may be lost from the blood stream through drugs (water pills), vomiting or diarrhea, uncontrolled diabetes, or prolonged lack of drinking. Lack of blood volume is treated by giving fluids by vein. Blood is transfused if severe bleeding has occurred, but fluids are given first while waiting for the blood.

3) Heart damage: When enough of the heart muscle is damaged by lack of oxygen (heart attack), the heart cannot pump effectively even if everything else is normal. This can be helped somewhat by giving the heart more fluid to pump, drugs to help the remaining heart muscle contract more effectively, and drugs which raise blood pressure by constricting blood vessels. All of these measures, however, have hazards and must be used carefully.

4) Drugs: Drugs can disturb the heart rhythm, decrease the ability of the heart to pump, and can dilate the blood vessels so that less blood comes back to the heart (blood vessel dilation deprives the heart of blood just like bleeding). Some such drug effects can be reversed with other drugs, but others will last as long as the drug is in the body. Be careful not to use unnecessary drugs.

5) Chemical and temperature changes: The heart uses potassium, calcium, and sodium for its electrical activity and pumping action. Too much or too little of any electrolyte (the name given to any normal body chemical which affects electrical activity) can make the heart malfunction. Too much acid or too much bicarbonate in the blood stream also prevents normal heart activity. Abnormally low temperature slows the heart, then finally upsets the rhythm. Treatment for any chemical derangement is to add whatever is missing. Too much of a chemical is much more difficult, and much slower, to treat.

<u>A GENERAL LOOK AT TREATMENT:</u> There are some basic principles which apply to all the patients you will be treating. Assumming that CPR is being given, every patient needs an IV and an endotracheal tube. An IV is essential to give the patient the medication he needs. The endotracheal tube allows better artificial respirations, makes CPR more efficient, and prevents vomit from getting into the lungs. One does not, however, delay immediately beneficial steps in order to get the ET tube in. For example, if a patient goes into V-fib in front of you, you don´t spend your first minute of CPR intubating--you grab the defibrillator, and a few seconds later the patient is alive and well. But in any continued cardiac arrest, you intubate as soon as practical.

The key to resuscitation is to get everything that you can back to normal, including blood chemistry, blood volume, and heart rhythm. The most important abnormality to correct is acidosis. If the patient has been in arrest for more than two minutes without CPR, bicarbonate must be given before

defibrillating. Then, because CPR does not give enough blood pressure to prevent further acidosis, a smaller dose of bicarbonate is given at regular intervals to keep the pH near normal. Ideally, the pH of the blood will be measured by arterial blood gas tests to determine how much is needed. Usually no more bicarbonate is given after the patient gets a blood pressure (because no more acid builds up).

The patient who arrests in the presence of the emergency personel, and whose EKG shows V-fib or V-tach, should have an attempt at defibrillation immediately. Nothing else is done first. If the first shock doesn't work, defibrillate again. In this patient, the first priority is to try to get the normal rhythm back.

After correcting acidosis, any patient in cardiac arrest should have the heart stimulated with epinephrine (adrenaline). The epinephrine is repeated every 5 minutes until a blood pressure is obtained.

Treating a cardiac rhythm problem need not be complicated. If the rhythm is abnormal and fast (V-fib, V-tach, or even Atrial fib if the patient is in shock), you defibrillate. If the rhythm is so slow that there is a low blood pressure (or no blood pressure) you give drugs, usually in a specific order.

Blood gases and electrolyte tests are drawn as soon as possible to look for abnormalities which can be corrected. As a general rule, it is best to leave a MILD abnormality alone. You can do the patient a lot of harm by adding a drug to treat something which is not bothering him at all. If, from the history, blood loss or fluid loss is suspected, fluids (saline) are given rapidly IV so that the heart will have enough fluid to pump.

For any abnormality which cannot be corrected, or which can only be corrected very slowly, certain drugs can provide help. For example, if the heart is irritable because of a heart attack, you cannot undo the damage. You have to treat the irritability with a drug, accepting the possible side effects.

WHAT HAPPENS DURING RESUSCITATION

First, the diagnosis of cardiac arrest is made based on unresponsiveness, absent respirations, and absent pulse. The resuscitation team rushes to begin their duties. If out of the hospital, the team consists of two emergency medical technicians (EMT´s) and two paramedics, directed by the emergency doctor by radio. If in the hospital, the team consists of a triage nurse, medication nurse, recording clerk or nurse, a nurse or EMT to give chest compressions, and a respiratory therapist to give artificial respirations. The emergency physician interprets the EKG, gives orders, and performs certain proceedures.

A "crash cart" is rolled up to the patient. It contains the drugs used in cardiac resuscitation, plus supplies such as endotracheal tubes. An EKG monitoring screen often sits on top of the cart, with a defibrillator.

One team member begins chest compressions. The sternum is pushed down about 2 inches to pump blood through the chest. This pumping, however, does not provide enough blood to keep the patient alive for long, so it is important to get the heart beating again.

Another team member is providing respirations, either with a bag and mask, or through the endotracheal tube after it is passed. In some hospitals, the chest compressions and respirations are done by a machine called a Thumper.

Electrical cables on the patient transmit the heart´s electrical activity to the EKG monitor. An IV is started.

The medication nurse prepares and administers medicines when ordered, and charges the defibrillator (since it usually sits on top of the crash cart containing the medicines).

The triage nurse assists in seeing that the physician´s orders are carried out smoothly, helping with medication and supplies. This nurse "directs traffic."

The recorder jots down medication and proceedures together with the time. He/she may remind the doctor if the patient is ready for another bicarb or epi dose.

Contrary to what you have seen on TV, the physician does not jump about, shout, and flail his arms. Such activities disturb brain cells. He examines the patient for clues, tries to get any information about the patient which might help, then orders each step in the treatment plan. The physician decides when the patient is doing well enough to transfer. He may order the resuscitation stopped and declare the patient dead if the situation is looking hopeless after 30 minutes or so.

In this simulation, all of these team members are at your disposal, so all you have to do is watch the monitor, think, and order. You may take as much time as you want between each "minute" of the program to study the manual, with the eventual goal of having all the information you need in your head.

REFERENCE VALUES FOR THIS SIMULATION

Pulse:
- above 150 severe tachycardia
- above 100 tachycardia
- NORMAL 60-100
- below 60 bradycardia
- below 45 severe bradycardia

Blood pressure:
- severe hypertension above 160/110
- hypertension greater than 140/90
- NORMAL 120/80, range 140/90 to 100/70
- hypotension less than 100/70
- severe hypotension below 60/20

Temperature:
- above 106 hyperthermia (heatstroke)
- NORMAL 98.6
- below 94 hypothermia
- below 89 severe hypothermia

ARTERIAL BLOOD GASES

pH:
- severe acidosis below 6.9
- moderate acidosis below 7.2
- mild acidosis below 7.35
- NORMAL 7.35 to 7.45
- alkalosis above 7.45
- severe alkalosis above 7.6

Oxygen (O2):
- NORMAL above 70 (higher on 100% O2)
- hypoxemia below 70
- severe hypoxemia below 50

Carbon dioxide (CO2):
- inadequate respirations above 40
- NORMAL 35-40
- hyperventilation below 35

Bicarbonate (HCO3-):
- severe alkalosis above 45
- alkalosis above 30
- NORMAL 24-28
- acidosis below normal
- moderate acidosis below 15
- severe acidosis below 5

Hemoglobin (Hgb):
- above 15 concentrated blood (poss. dehydration)
- NORMAL 12-15
- below 12 anemia
- below 9 severe anemia

ELECTROLYTES

Sodium (Na): NORMAL 134-144

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                  above 7.5 severe hyperkalemia
                  above 6.5 moderate hyperkalemia
                  above 5 hyperkalemia
Potassium (K):    NORMAL 3.5-5
                  below 3.5 hypokalemia
                  below 2.5 moderate hypokalemia
                  below 1.9 severe hypokalemia
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Chloride (Cl): NORMAL 80-100

Bicarbonate (HCO3): see above under ABG

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        above 20 kidney failure or dehydration
Blood urea nitrogen (BUN):NORMAL 5-20
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                  above 250 severe hyperglycemia (diabetes)
                  mild hyperglycemia expected with stress or IV
Glucose (Glu):    NORMAL 70-100
                  below 70 mild hypoglycemia
                  below 40 moderate hypoglycemia
                  below 20 severe hypoglycemia
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                  above 17 severe hypercalcemia
                  above 14 moderate hypercalcemia
                  above 10 hypercalcemia
Calcium (Ca):     NORMAL 8-10
                  below 8 hypocalcemia
                  below 5 moderate hypocalcemia
                  below 3 severe hypocalcemia
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SOME SPECIFIC PROBLEMS

Acidosis. Acid builds up in the blood stream when the tissues do not get enough oxygen-rich blood delivered to them. In the patient who is alive, acidosis can result from kidney failure, diabetic ketoacidosis, poisonings (like cyanide), and shock. Any patient in cardiac arrest becomes acidotic.. Acid makes the heart more irritable and makes it pump less effectively. This acid buildup can be neutralized with sodium bicarbonate. That is why, if the patient has been in cardiac arrest for more than 2 minutes when CPR is started, bicarbonate is injected by vein initially. No bicarb is given initially if the patient has just arrested--there has not been enough time for acid buildup. Bicarb is given every ten minutes until the patient develops a pulse. Monitor the acid-base status with blood gases (ABG). If the initial dose of bicarbonate did not raise the pH above 7.2, your next dose should be the usual amount (1/2 millequivalent per kilogram every ten minutes) plus about one tenth of the person's weight in kilograms times the difference between his serum bicarb (HCO3-) and 25 (Additional bicarb = (25-HCO3)xWt/10). If the person has been acidotic a long time (such as kidney failure or diatetic ketoacidosis), more (two times more) bicarb will be needed, but it is hazardous to try to correct the total deficit suddenly. Overcorrecting the pH results in alkalosis, so use the ABG liberally to determine how much bicarbonate is needed. Leave a mild acidosis (pH above 7.25) alone.

Agonal rhythm. Occasional wide, abnormal electrical waves are seen, but there is no pulse. This rhythm means trouble. It usually means that the patient has already suffered such severe heart damage that there is no hope of recovery. Treat it essentially like asystole (see below).

Alkalosis. Too much bicarbonate in the blood stream usually results from too much bicarbonate being given by vein. It can occur also by prolonged vomiting up of stomach acid or severe hyperventilation. Alkalosis is very difficult to treat. Since there is nothing on the "crash cart" to treat it, this program gives you no way to save the patient if you give an overdose of bicarbonate. Alkalosis makes the heart very difficult to defibrillate and makes the delivery of oxygen from the red blood cells less effecient. If the pH is above 7.25, be happy and don't risk alkalosis by giving extra bicarb.

Anaphyllactic shock. A severe allergic reaction sometimes causes dilation of all blood vessels in the body. This results in low or absent blood pressure and coma. The rhythm is usually sinus tachycardia. Treatment with epinephrine usually gives immediate, dramatic improvement. By constricting all the body's blood vessels, epinephrine gives back to the heart the blood which has pooled in the dilated

arteries and veins.

Anemia. See Hemorrhage.

Asystole. No electrical activity at all on the monitor usually means a grim future. It very rare for anyone in asystole to leave the hospital alive. No electrical activity means a very severely affected heart. If it results from electrolyte problems, you may save the patient. Get the pH as close to normal as possible. While awaiting lab, make sure that epinephrine is given frequently. Give atropine up to the maximum dose. Try an isoproterenol infusion as a last resort. A pacemaker is forbidden. Try defibrillating just in case the asystole is really very fine ventricular fibrillation.

Atrial fibrillation. Unorganized activity in the upper chamber (atrium) can allow electrical impulses to get into the lower chamber irregularly. It is recognized by irregularly spaced QRS complexes, and an irregular baseline between beats. If the rate is close to normal and there is a good blood pressure, then leave it alone. If there is no pulse or very low blood pressure, then defibrillate. If the rate is rapid but there is a fair blood pressure, treat with drugs which increase conduction blockage (digoxin, verapamil).

Block. see conduction block or bundle branch block.

Bradycardia. A heart rate which is much too slow does not provide good blood flow. It often results from a heart attack or drugs, but can also be seen in hypothermia or electrolyte problems. If the blood pressure is good, do not treat the bradycardia. Treat bradycardia first with atropine, up to the maximum dose. Epinephrine provides temporary stimulation, but "costs" the heart a lot more than atropine. If still severe, try an isoproterenol infusion. A pacemaker would be a last resort, but this program refuses to allow a pacemaker.

Bundle branch block. Part of the conducting system is not working right. It may occur because of electrolyte problems, heart attack, or hypothermia while the rest of the conducting system is still working. While it may alert you to a problem, by itself it requires no treatment. Often, however, bundle branch block is accompanied by AV conduction block which DOES require treatment (see below).

Cardiogenic shock. When enough heart muscle is damaged, the heart can no longer pump effectively. When the blood pressure stays low despite a good rhythm, with no cause other than a heart attack, consider cardiogenic shock. If there is some reason to think that the patient has low blood volume, such as use of diuretics (water pills), carefully try a little saline infusion (about 500 cc over 15

minutes--remember to tell the nurse to turn the thing off). Dopamine or dobutamine can help raise blood pressure, but also must be used carefully. Dopamine increases the irritability of the heart, so in the case of a heart attack, you might want to give lidocaine first. Depending on how much "reserve" the patient has, if over 40 to 45% of the heart muscle has been destroyed, the patient will ultimately die. Sorry, fans, but nitroprusside is not available because it takes too long to mix for E.R. use.

Coma. Coma means unconsciousness. It may be temporary following cardiac arrest, in which case the patient will become conscious within a few minutes. Prolonged or unexplained coma may be due to brain damage, drugs such as narcotics, severe hypoglycemia, heat stroke, hypothermia, or electrolyte problems. A standard approach to unexplained coma is to draw lab, then give DEXTROSE and NALOXONE (NARCAN) I.V.

Conduction block. When the impulses from the atrium are being stopped from reaching the ventricle, the heart rate can slow enough to cause shock or cardiac arrest. If the impulses are merely being slowed (first degree AV block) but not stopped from reaching the ventricle, this requires no treatment. Conduction block can be caused by heart attack, drugs, hypothermia, or electrolyte problems. In addition to epinephrine, bicarb, and drawing lab to look for a specific problem, try to speed up the pacemaker and decrease the blockage with drugs. Atropine is the first choice--give the maximum amount before trying anything else. An isoproterenol drip is the second choice. An artificial pacemaker is the next step, but you aren't allowed to use it in this program.

Dehydration. Loss of fluid from the blood stream can result in shock, but it usually does not result in cardiac arrest until other problems develop (acidosis, electrolyte abnormality). When dehydration develops, there is usually a loss of electrolytes along with the fluid (usually potassium). Dehydration can result from use of diuretics, severe vomiting or diarrhea, kidney disease, hormone abnormalities, diabetes, losses through the skin (burns or severe sweating), or reduced fluid intake. Clues to dehydration will be found in the history, but also watch for a higher than normal hemoglobin concentration on the ABG, and hypotension with tachycardia. Treat by replacing fluids with saline or ringer's until the blood pressure is normal. Watch the electrolytes.

Heart attack. See myocardial infarction.

Heatstroke. See hyperthermia.

Hemorrhage. Hemorrhage is loss of blood through bleeding. It may not be obvious if the bleeding is into the chest or abdomen. There should be a history of trauma or obvious

blood loss. The blood hemoglobin (Hgb) will fall as the body puts other fluids into the blood stream to try to keep the total blood volume up. Expect tachycardia, then falling blood pressure as shock develops. Treatment is first to try to support the blood pressure with fluids. Transfuse blood if the hemorrhage is severe enough to lower the blood pressure. Support of the blood pressure with dopamine may help, but this only buys time--it does not "fix" the problem.

Hypercalcemia. Too much calcium in the blood stream can result from hormone problems, cancer in the bones, or kidney trouble. Calcium effects the electrical system of the heart, lengthening the PR interval, shortening the ST interval, and shortening the T wave. The heart becomes more irritable. A patient with severe hypercalcemia will usually also be severely dehydrated. Deliberately causing a MILD hypercalcemia by giving calcium by vein helps stabilize the heart when too much potassium is present (see hyperkalemia). Treatment for hypercalcemia is to treat heart block (if present) with atropine, reduce irritability (see below) if present, and to start a rapid saline infusion to correct dehydration and to flush the calcium out the kidneys (assuming the kidneys work). The program does not allow you enough time to see the calcium level fall.

Hyperglycemia. A high blood glucose is called hyperglycemia. Do not treat mild hyperglycemia. A severely high blood sugar by itself does not cause cardiac arrest, but the dehydration which it causes can cause shock, with cardiac arrest following. In one type of diabetes, acidosis occurs early, but in the other more deadly type, acidosis occurs only as shock develops. Diabetic acidosis (called ketoacidosis if ketones are present in the blood) is diagnosed by glucose above 250 and low pH. There is usually tachycardia, plus hyperventilation if the patient is breathing on his own. There may be a lack of potassium as well, even though the potassium may appear normal on an initial electrolyte test. Keep in mind that diabetic ketoacidosis often is caused by a major stress, such as a heart attack. Treatment is insulin, rapid fluid infusion, and bicarbonate if needed. Watch the electrolytes.

Hyperkalemia. High blood potassium is called hyperkalemia. It can result from kidney failure, certain drugs, crushed muscles, hemolysis (red blood cells bursting in the blood), or potassium supplements. As the potassium increases, one first sees tall, peaked T waves, then at a potassium level of around 6.8 to 7.5 the QRS widens, and conduction block or bundle branch block may develop. The P wave may disappear. The heart becomes prone to fibrillation. Treatment is calcium (this changes some of potassium's effects on the heart) and enough bicarbonate to make the patient a little alkalotic (pH about 7.5). The serum potassium varies inversely with the pH: if the patient is acidotic, the potassium is higher; if alkalotic the potassium level

decreases somewhat. A glucose-insulin infusion drives potassium into the cells, decreasing the blood level. Use it carefully, watching the potassium level.

<u>Hypertension.</u> High blood pressure should not be treated on an emergency basis unless complications of the high blood pressure are evolving (intracerebral bleeding, dissecting aortic aneurism, worsening heart attack, etc). A high blood pressure increases the work of the heart, and therefore makes it need more oxygen. Hypertension may worsen a heart attack. It may be treated in various ways, most of which you might later regret. But if the patient needs it, you can lower blood pressure with PROPRANOLOL, DIAZOXIDE, VERAPAMIL, or MORPHINE. In the setting of a heart attack, relieving the pain with morphine is a desireable goal, and will usually also bring the blood pressure down. If MORPHINE alone is not effective to stop the hypertension, then DIAZOXIDE is the next choice. Be careful. PROPRANOLOL and VERAPAMIL are best avoided if possible, but there may be a situation where one of these might be needed.

<u>Hyperthermia.</u> Heatstroke can occur when exercizing in a hot environment. Dehydration or underlying medical problems make heatstroke more likely. Diagnosis is by finding an altered mental status with rectal temperature above 106 degrees. There may be other problems present also. Treat any immediate instability, then dunk the patient in an ice bath. Monitor the temperature so you don´t freeze the patient.

<u>Hyperventilation.</u> A conscious patient may hyperventilate because of pain, anxiety, or acidosis. A low carbon dioxide (CO2) gives the diagnosis. Treat only the underlying cause. A somewhat low CO2 is common during CPR because of the artificial respirations.

<u>Hypocalcemia.</u> A deficit of calcium can result from hormone abnormalities, bowel disease, or dietary deficiency. The heart is affected electrically, and cannot contract as strongly, finally becoming more prone to fibrillation. EKG clues are a shortened PR interval with a long ST segment and long T wave. A second "U" wave just after the T wave may be seen--this wave can also be inverted. Treatment (assuming that the patient is in trouble because of it) is calcium by vein. Give about 10 mg per kg for every 1 unit rise desired in serum calcium. <u>Do</u> <u>not</u> treat a low serum calcium unless you are certain that it is affecting the patient´s heart.

<u>Hypoglycemia.</u> The brain and heart need sugar to operate. Severe hypoglycemia, an extremely low blood sugar, can cause coma. If the coma is deep enough that the patient stops breathing, cardiac arrest can result. Any patient in undiagnosed coma should get an ampule of dextrose IV (order electrolytes first so you´ll know what the original blood sugar was).

Hypokalemia. A lack of potassium in the blood is called hypokalemia. It usually results from diuretics (water pills), but can also occur with hormone problems, or with various causes of dehydration (vomiting, diarrhea). The heart becomes more irritable, and more sensitive to digoxin side effects. The T wave widens, then an extra wave (U) appears after it. Below a level of 2, the ST segment becomes depressed. Treatment of severe hypokalemia (causing cardiac problems) is potassium IV, given SLOWLY by a pump. Reorder electrolytes frequently.

Hypotension. Low blood pressure slowly starves the tissues. As the heart and blood vessels become affected by the hypotension, a vicious circle develops--the heart pumps more poorly and the blood vessels cannot contract to maintain the pressure, so the blood pressure drops further and the heart and blood vessels function even more poorly. Try to treat the CAUSE of the low blood pressure. If low blood pressure results from a rhythm disturbance (either too slow or too fast), then treat that rhythm. Look for any chemical abnormality, and consider the possibility of drugs. If the history hints at fluid loss (dehydration) or blood loss, start replacing lost fluids. Cardiogenic shock is low blood pressure resulting from a severe heart attack (see above). If there is no "fixable" cause, or while waiting for enough fluid to be given IV, support the blood pressure with a DOPAMINE INFUSION.

Hypothermia. An abnormally low body temperature is called hypothermia. It results from exposure--drunks or addicts out in the cold, drowning victims, newborns exposed to cool air. These victims often seem stiff, cold, and dead. No person with a low body temperature is dead until they are warm and dead. Diagnosis is by rectal temperature (usually below 92) using an electric thermometer. EKG typically shows sinus bradycardia with everything slowed down--prolonged PR, wide QRS, depressed and prolonged ST segment, long T wave. There is hypotension, progressing to acidosis and cardiac arrest. Treatment of hypothermia is "core" warming. The center of the body is warmed using warm NG lavage (or peritoneal dialysis), and warmed air through the ET tube.

Irritability. Many problems, including most heart attacks, make the heart prone to abnormal rhythms. If the heart keeps reverting back to V-fib or V-tach, we call this irritability. Think first of any chemical abnormality: acidosis or an electrolyte abnormality may be the cause. If you have not overlooked an obvious cause, then give a lidocaine bolus. Defibrillate if necessary, then draw ABG and lytes. Start a lidocaine drip.

Myocardial infarction. Death of heart tissue from lack of oxygen is called myocardial infarction, or "heart attack." The dead and dying tissue causes irritability (see above) and decreased efficiency of heart pumping. The larger the area

of damage, the bigger the problems which it can cause. To prevent ventricular fibrillation, give lidocaine automatically to any heart attack victim.

<u>Narcotic overdose.</u> One automatic response to an unexplained coma is to give a full dose of Naloxone (Narcan). This completely reverses any narcotic effects, without any concern of side effects. Hypotension, shallow respirations, and coma are clues that there might be a narcotic coma. There are no EKG signs. Narcotic coma can progress to cardiac arrest when the dose is high enough to stop the patient from breathing.

<u>Overdose.</u> An oral overdose of medication requires that the stomach be emptied. In a stuporous, comatose, or unstable patient, this means placing an NG tube to suck out any remaining medicine. Specific measures for a particular drug may be required, but the most important first steps are: 1) get control of the patient's airway by placing an ET tube, 2) place an IV, and 3) empty the stomach. Charcoal and laxatives usually follow, but those options are not available in the simulation.

<u>Right bundle branch block.</u> See bundle branch block.

<u>Sinus bradycardia.</u> See bradycardia.

<u>Sinus tachycardia.</u> Sinus tachycardia usually results from overstimulation of the heart. If the blood pressure is normal, leave it alone. Never try to slow sinus tachycardia when the blood pressure is low--the tachycardia is merely a reaction to some other problem, such as hemorrhage or anaphyllactic shock. If the blood pressure is quite high, both the blood pressure and the tachycardia can be treated with a drug like propranolol, but you might want to wait a few minutes until the last dose of epinephrine wears off to see if the epi is the cause.

<u>Shock.</u> See hypotension.

<u>Ventricular fibrillation.</u> Unorganized electrical activity in the ventricle can result from heart attack, electrolyte abnormality, abnormal acid-base balance, or hypothermia. The heart cannot pump at all. If the patient has been in cardiac arrest for more than a couple of minutes, then give a full starting dose of bicarb and epi, then defibrillate, shocking again if the first defibrillation was unsuccessful. If the patient has just gone into cardiac arrest, then treatment is immediate defibrillation, repeated immediately if V-fib persists. If the fibrillation is resistant to both shocks, give bretylium and defib again. Add lidocaine if still resistant. Get lab tests and keep trying to defibrillate while waiting. A higher setting gives a better chance of conversion to normal rhythm. Recurrent V-fib (irritability) should be treated with lidocaine, while you look for any treatable problem such as acidosis which could be causing the

irritability.

Ventricular rhythm. If slow and accompanied by hypotension or cardiac arrest, treat it as you would a severe conduction block (see above). If the blood pressure is good, leave the rhythm alone.

Ventricular tachycardia. Caused by factors similar to V-fib, V-tach is a more organized, regular ventricular rhythm which can occasionally give a pulse. Even with a fair blood pressure, V-tach will usually degenerate into V-fib. If the blood pressure is quite low (or if there is no pulse), defibrillate. In treating, follow the same sequence as with V-fib, except use lidocaine as the first choice drug rather than Bretylium if the V-tach resists defibrillation.

ORDER LIST, EQUIVALENT TERMS, AND EXPLANATIONS

PROCEEDURES:

DEFIBRILLATE (DEFIB, CARDIOVERT, CARDIOVERSION, SHOCK): The defibrillator is set at 200 watt-seconds as resuscitation begins. If you want another setting, you must specify. The defibrillator will then still be at this new setting the next time you order defibrillation. 200 watt-seconds (joules) is the recommended starting setting to defibrillate a normal adult. The stronger the setting, the greater the chances of converting the patient to a normal heart rhythm (but if the heart has a serious problem it may re-fibrillate by the time the rhythm re-appears on the monitor). Defibrillators have a maximum setting of 350 or 400 (our maximum is 400). For children, use a setting of 2 to 4 joules per kilogram of weight, rounding off to the nearest multiple of 25.

Indications: V-fib. Also use for V-tach or atrial fib if there is absent pulse or significant hypotension.

Actions: Electrically "fires" all of the heart at once, stopping abnormal "short circuits." Often the heart will then resume a normal rhythm.

Precautions: Excessively high settings will "electrocute" some of the heart muscle.

SAMPLE ORDERS:

DEFIB (will use 200 if no other setting specified previously)

DEFIBRILLATE AT 50 JOULES

SET TO 350 AND SHOCK HIM

OBSERVE (WATCH, WAIT, NOTHING): If no orders are planned, you may simply hit RETURN without entering anything. Hitting RETURN advances one minute. If you want several minutes to pass while you are waiting for lab or for improvement, you can order a specific number of minutes of observation. If you give no number, the simulation advances only one minute. There will still be an EKG printed out for each minute. The program will override your observation order if the patient "crashes" or lab tests come back, allowing you to enter new orders.

Indications: waiting for lab, waiting until the ICU is ready, waiting to see how a patient improves after treatment.

Actions: advances simulation until specified number of minutes has passed, until blood pressure falls markedly, or until lab tests are returned (whichever comes first).

Precautions: You cannot interrupt the observation in process if you remember that you forgot to order something.

SAMPLE ORDERS:

WAIT 5 MINUTES

OBSERVE 3 MINUTES

WATCH HIM DIE

IV (I.V., INTRAVENOUS LINE): Medication nurse starts an IV.

Occasionally, the IV cannot be easily started. This gives you practice at giving drugs endotracheally. You do not need to keep asking that the IV be started--the med. nurse keeps working at it until it is running, then tells you. The IV is always Dextrose 5% in water (D5W) unless you specify saline or ringer´s.

Indications: only route by which most drugs used in resuscitation can be given. Fluid or blood can be given if needed. An IV must be started on every patient.

SAMPLE ORDERS:
PLACE IV
START I.V. WITH LACTATED RINGER´S

ENDOTRACHEAL TUBE (ET TUBE, E.T. TUBE, INTUBATE): You (or the paramedic or anesthesiologist) place a breathing tube down into the patient´s trachea. This proceedure takes second place to defibrillating and starting an IV. In many situations, you would not want to delay giving important drugs in order to intubate. But as soon as possible, place the ET tube (unless the patient is conscious).

Indications: Intubate any patient in cardiac arrest or coma.

Actions: Prevents aspiration of stomach contents into lungs. Provides better oxygenation of blood. Makes CPR more effective (yes, the program takes that into account, too).

Precautions: Do not delay life-saving actions in order to get the ET tube in.

SAMPLE ORDERS:
PLACE ET TUBE
LET´S INTUBATE HIM NOW

NASOGASTRIC TUBE (NG TUBE, N.G. TUBE): A tube is placed through the nose into the stomach by the team leader or med. nurse.

Indications: This relieves pressure and reduces risk of aspiration if the stomach becomes distended with air. Also useful to suck something out of the stomach (like an overdose of drugs). It can also provide a quick route for warm fluids in hypothermia.

Actions: empties stomach

SAMPLE ORDERS:
PASS AN NG TUBE
NASOGASTRIC TUBE TO SUCTION

WARM (WARMING): A patient who is hypothermic requires "core" warming. To save memory and time, the computer assumes that if you use the word WARM, you are ordering "core" warming (warm NG lavage, warm peritoneal dialysis, warm humidified air via ET tube) and NOT merely warm blankets (which are actually harmful in true hypothermia). So, even though you may get the right effect through the wrong order, order the correct type of warming or your monitor screen will break.

Indications: significant hypothermia (temperature below 94).

Actions: raises rectal temperature by about 1/4 degree

per minute if in cardiac arrest, or about 1/2 degree if the patient has a good blood pressure.

Precautions: stop the warming when the temperature is normal.

SAMPLE ORDERS:
CORE WARMING MEASURES
WARM NASOGASTRIC LAVAGE

COOLING (COOL, ICE, COLD): A patient with heat stroke (delirious or in coma with rectal temperature above 106) needs rapid cooling. Cooling can be both external (in contrast to the use of heat in hypothermia) or internal and still be effective.

Indications: heat stroke or impending heat stroke

Actions: lowers temperature by 1/4 to 1/2 degree per minute, depending on patient status

Precautions: Be sure to check the temperature frequently and stop the cooling when the temperature nears normal, or you will also get practice at treating hypothermia

SAMPLE ORDERS:
STAT ICE BATH
COLD NASOGASTRIC LAVAGE

TRANSFER (QUIT): Either of these orders will end the program IF you have completed at least 15 cycles. You then get an outcome for your patient, a listing of any problems detected by the computer, and a chance to try the same patient again.

SAMPLE ORDERS:
TRANSFER TO ICU
THIS GUY´S DEAD, LET´S QUIT

INFORMATION:

HOW LONG (WHAT TIME, WHEN WAS/WILL, LAST): You may ask the recording clerk for some simple bits of information without losing any "time" in the resuscitation. The question function covers only Epi (you have to give it every 5 minutes), Bicarb (every 10 minutes), Lidocaine (it wears off), blood gases and electrolytes.

Indications: closer control of the patient without wasting time looking at the flowsheet.

SAMPLE ORDERS:
WHEN WILL THE LYTES BE FINISHED
HOW LONG SINCE THE LAST BICARB
WHEN WAS THE LAST ABG
LAST EPI?

TEMPERATURE (TEMP): Someone will take the patient´s temperature if you ask for it.

Indications: blood gases may be inaccurate in cold or feverish patient if someone assumes that the temp is normal. Checks for hypothermia or hyperthermia.

SAMPLE ORDERS:
GET A TEMPERATURE

RECTAL TEMP

FLOWSHEET (CHART): A record is kept of your orders. You may look at it. It takes you one "minute" to review the chart. It can be very helpful to look over your past orders when you're stumped.

Indications: prevents overlooking the effects of something (like a high-dose infusion) you ordered before. Helps you total up total drug doses (like bicarb).

Precautions: "costs" you one minute--not to be used frivilously.

SAMPLE ORDERS:
LET ME SEE THE CHART
FLOWSHEET

LAB TESTS:

DRAW (GET, ORDER): Takes blood for laboratory test. Only two tests are available: an electrolyte panel and arterial blood gases. CBC (Blood count) is not available (all you really need is the hemoglobin in the ABG anyway). Only one test (which you must specify) is recognized per order. DO NOT order a specific value (potassium or calcium level, for example) because the computer thinks of these as drugs and will ask you how much you want to give.

BLOOD GASES (ABG, GAS, ABGS, ABG'S, PH): Arterial blood is tested for pH, oxygen, CO2, bicarbonate, and hemoglobin. These values are returned to you after five minutes (five program cycles). Use ABG to guide your bicarbonate therapy.

ELECTROLYTE PANEL (LYTES, CHEMISTRY, ELECTROLYTES): Venous blood is tested for sodium, potassium, chloride, bicarbonate, glucose, urea nitrogen, and calcium. The test takes ten minutes (ten cycles) to run. Every patient should have an electrolyte panel drawn.

SAMPLE ORDERS:
GET LYTES
DRAW AN ABG
ORDER ELECTROLYTES

ORDERING DRUGS: general information

If the drug is to be given as a single injection (bolus), then you must give the computer all the needed information when you enter the order. That means you should give the name of the drug, the dose (in numbers), and the units (CC, MG, AMP). If the drug is to be given endotracheally, you must also specify that. If no route is specified, the program assumes that you want the drug given IV. If you are ordering the drug in pediatric strength, you must also specify that in the order.

If the drug is to be given as an infusion, simply state the drug name and specify INFUSION or one of its equivalents (below). Only specific drugs can be ordered as an infusion. The "artificial intelligence" in the program is rather dumb, and cannot figure out a "custom" strength infusion for you. You will be asked what rate of drug administration you want based on a standard mix.

To change the rate of an infusion, simply order it increased or decreased, and the medication nurse will ask you what rate of drug infusion you want. To stop an infusion, order it stopped.

If a reasonable order is not being recognized or is being treated differently than you expect, first check your spelling. Make sure that you are using an acceptable word or abbreviation. Check to see if you are using some other word which the computer recognizes as an order.

RECOGNIZED WORDS AND EQUIVALENT TERMS:

Units

MG (MILLIGRAMS, MILLIGRAM)
CC (CC'S, ML, MILLILITER, MILLILITERS, C.C.)
AMP (AMPS, AMPULE, AMPULES)
MEQ (MILLIEQUIVALENT, MILLIEQUIVALENTS)

Routes

IV (I.V., BY VEIN, INTRAVENOUS)
ET (ENDOTRACHEAL, ENDOTRACHEALLY, E.T.)
INFUSE (INFUSION, DRIP, IVAC, PUMP)

Strengths

PEDIATRIC (PEDI, SMALL, NEONATAL)
REGULAR (ADULT, LARGE)

Cancelling

STOP (DC, D.C., D/C, CANCEL, HOLD)

DRUGS AVAILABLE:

ATROPINE blocks the effects of a specific body chemical and a specific nerve which can slow the heart and increase conduction block. It therefore usually will speed the heart and decrease the blockage in the AV node.

Supplied: AMPULE = 5 CC = .5 MG

Usual dose: adult--1 amp, repeated up to a total dose of 2 mg

child--.01 mg/kg, repeated up to three times

May be given ENDOTRACHEALLY.

Indications: bradycardia or high-grade AV conduction block, unless blood pressure is good.

Actions: speeds up atrial pacemaker, decreases blockage within AV node.

Precautions: doses lower than those recommended may actually slow the heart further. Increased heart rate may make a diseased heart work harder, resulting in a larger area of heart damage.

SAMPLE ORDER:
ATROPINE .1 MG ET
10 CC ATROPINE

BICARBONATE (BICARB) neutralizes acid. It is used to reverse the acidosis which results from cardiac arrest.

Supplied: AMPULE = 50 CC = 44 MEQ
PEDIATRIC AMPULE = 10 CC = 8.8 MEQ

Usual dose: 1 MEQ/kg (usually 2 amp for an adult) initially (Give this initial dose only if the patient has been in cardiac arrest without CPR for several minutes), then 1/2 MEQ/kg every ten minutes until a blood pressure is achieved. STOP giving bicarb once the patient has a blood pressure, and wait for a blood gas to tell you if more is needed.

Indications: cardiac arrest, or proven acidosis.

Actions: directly neutralizes acid.

Precautions: if given in excess, alkalosis results, which is very difficult to treat. Use of the an immediate dose in a witnessed arrest will guarantee severe alkalosis. Use ABG to guide therapy.

SAMPLE ORDER:
20 CC OF BICARB IV
BICARBONATE 2 AMPS

BLOOD (PRBC, RBC'S, RBC, PRBC'S, CELLS) is given in this simulation only as packed red blood cells. Used to raise the hematocrit after hemorrhage, packed cells should be accompanied by aggressive fluid replacement (ringer's or saline). It takes the blood bank five minutes to get the blood ready. The rate of infusion depends on the size of the patient. The nurse will tell you when the blood is finished. One cannot predict exactly how far the hematocrit will rise with the transfusion, because of other factors (dilution by saline, amount of total volume loss, etc).

Supplied: UNIT = 250 CC (approx)

Usual dose: monitor by checking hemoglobin on ABG. Typically at least 2 UNITS should be given for significant hemorrhage (about 10 cc per kg of body weight for children).

Indications: severe anemia.

Actions: provides blood volume and red blood cells.

Precautions: none in this simulation.

SAMPLE ORDERS:
2 UNITS PRBC
15 CC PACKED CELLS

BRETYLIUM (BRETYLOL) is useful in resistant V-fib. After use, the heart can often be successfully defibrillated when it could not before.

Supplied: AMPULE = 500 MG = 10 CC

Usual dose: 5 mg/kg, repeat if not effective.

Indications: Ventricular fibrillation resistant to defibrillation. Remember that you still have to defibrillate after giving Bretylium.

Actions: allows easier conversion to sinus rhythm. Also blocks nerves which affect blood vessels, reducing blood pressure somewhat.

Precautions: may exacerbate cardiogenic shock

SAMPLE ORDER:
BRETYLIUM 350 MG

CALCIUM is supplied as calcium chloride. Calcium stimulates the heart, resulting in stronger contractions. It may, however, do more harm than good when used routinely in cardiac resuscitation. If there is significant hypocalcemia (enough to cause a disturbance of heart rhythm or pumping), however, calcium is needed.

Supplied: AMPULE = 10 CC = 1000 MG

Usual dose: .1 cc/kg, repeated once if necessary.

Indications: hypocalcemia which is causing rhythm disturbance, severe hyperkalemia, electromechanical dissociation (this means a good EKG but no pulse. It is hotly debated whether calcium should truly be used for this, but the current ACLS guidelines call for it. First rule out acidosis and electrolyte abnormality before making this diagnosis)

Actions: raises the serum calcium, increases the force of cardiac contraction. Counteracts the effects of excess potassium on the conducting system.

Precautions: hypercalcemia may develop. May be detrimental to the ultimate fate of the heart and brain.

SAMPLE ORDER:
CALCIUM 4 CC
1 AMP CALCIUM CHLORIDE

DEXTROSE in this simulation means 50% dextrose. This is a form of sugar. It provides energy for the brain and heart when the blood glucose is low.

Supplied: AMPULE = 50 CC = 25 MG

Usual dose: adult--1 amp
child--1 cc/kg

Indications: any undiagnosed coma, suspected hypoglycemia, probably should be used routinely in infants in cardiac arrest.

Actions: raises blood sugar quickly.

Precautions: Although not harmful, electrolytes taken after injection will show a very high blood sugar which could be confused with diabetes. Draw lab first.

SAMPLE ORDER:
DEXTROSE 1 AMP
13 CC DEXTROSE IV STAT

DIAZOXIDE (HYPERSTAT) is used to lower blood pressure. It is a fairly long-lasting drug, and is not to be used except in severe hypertensive emergencies. It is rarely used in a cardiac arrest situation, but is included as an option because it is contained in most "crash carts."

Supplied: AMPULE = 300 MG = 20 CC

Usual dose: 1 to 3 mg/kg, up to a total of 150 mg

SAMPLE ORDER:
DIAZOXIDE 100 MG IV

DIGOXIN (LANOXIN) is used to increase the force of the

heart's pumping in a person with a sick heart, or to reduce the heart rate of a person in atrial fibrillation by increasing AV block. The drug has substantial hazards and usually is best avoided in cardiac arrest situations. Rarely, you might find need for it.

Supplied: regular--AMPULE = 2 CC = .5 MG
pediatric--AMPULE = 1 CC = .1 MG

Usual dose: start about .005 mg/kg (.25 to .5 in an adult) and titrate up to effect, not to exceed .02 mg/kg

Indications: atrial fibrillation with rapid ventricular rate (consider also verapamil), cautious use in cardiogenic shock

Actions: increases effectiveness of cardiac muscle, partially blocks AV node, some effect on SA node

Precautions: may slow sinus rate. Makes heart more prone to abnormal rhythms. Safe dosage range is very narrow--harmful effects may occur even at usual doses. May produce complete heart block if the AV node is already partially blocked.

SAMPLE ORDER:
.5 CC PEDIATRIC STRENGTH LANOXIN
DIGOXIN .25 MG

DOBUTAMINE (DOBUTREX) increases the heart's contractility similar to dopamine (below), but does not constrict the blood vessels nor raise the blood pressure to the same degree. Used mostly for congestive heart failure in the ICU. Not very useful for cardiogenic shock, but may help in a "borderline" situation where a little extra contractility is desired without the increase in heart work and irritability that dopamine would cause.

Supplied: must be mixed as infusion. Protocols vary.

Usual dose: start at about 2.5 micrograms/kg/min and increase as needed. Best not to exceed 20 to 30 mcg/kg/min.

Indications: rarely used in the E.R. Limited use where increased heart contraction force is desired.

Actions: stimulates the heart to contract more forcefully.

Precautions: may waste time when dopamine would be more effective. At higher doses, increased heart rate and increased heart irritability occur.

SAMPLE ORDER:
DOBUTAMINE INFUSION

DOPAMINE (INTROPIN) is useful for raising low blood pressure. It stimulates the heart, resulting in a more rapid rate and more forceful contractions. It constricts blood vessels, raising the pressure. These effects increase the heart's need for oxygen (which can increase the severity of a heart attack) and make it more prone to abnormal rhythms. It is usually the first choice drug for all forms of shock.

Supplied: must be mixed as an infusion. Protocols vary from hospital to hospital, but all have charts which show how a specific dosage in mcg/kg/min translates into cc/hour or drops/minute.

Usual dose: begin in the range of 1 to 5 micrograms/kg/min (depending on the severity of shock), and increase until the desired effects are seen. Best not to exceed 30 to 40 mcg/kg/min.

Indications: shock. Fluids should also be given IV if the shock is due to low blood volume.

Actions: stimulates the heart, increasing heart rate, force of contraction, and irritability of the heart. Constricts blood vessels. Raises blood pressure.

Precautions: increases the risk of fibrillation. May increase the severity of a heart attack (but persistantly severe low blood pressure will do more damage).

SAMPLE ORDER:
DOPAMINE DRIP

EPINEPHRINE (EPI, ADRENALINE) stimulates the heart. It raises blood pressure, increases the heart rate, and increases the heart´s irritability. It is used during cardiac arrest because 1) it is an extremely potent cardiac stimulator, and 2) it makes fibrillation more course and easier to convert to sinus rhythm. It is not used routinely to raise blood pressure except in anaphyllactic (allergic) shock. This drug occurs naturally in the body, and is degraded over several minute´s time.

Supplied: AMPULE = 10 CC = 1 MG

Usual dose: adult--1 amp every five minutes until pulse and blood pressure achieved.

child--.1 cc/kg every five minutes until pulse and B.P.

May be given ENDOTRACHEALLY.

Indications: cardiac arrest, anaphyllactic shock.

Actions: potent cardiac stimulant, blood vessel constrictor.

Precautions: stop use when blood pressure obtained. If B.P. falls as Epi wears off, use dopamine.

SAMPLE ORDER:
EPI 1 AMP
10 CC ADRENALINE ENDOTRACHEALLY

INSULIN is a natural hormone which moves sugar into cells. The lack of insulin causes diabetes. Too much insulin results in low blood sugar. Only regular (fast acting) insulin is available, and its use is limited to IV bolus in this program (the E.R. doesn´t have time to set up those fancy infusions. Leave it to the ICU).

Supplied: drawn up from vial as needed, different strengths per cc, therefore ordered in "UNITS."

Usual dose: .2-.4 UNITS/kg IV bolus, repeated in 10-20 minutes.

Indications: diabetic ketoacidosis, or severe hyperglycemia.

Actions: lowers blood sugar

Precautions: may cause hypoglycemia, lowers potassium somewhat.

SAMPLE ORDER:

10 UNITS INSULIN IV

INSULIN-GLUCOSE (INSULIN/GLUCOSE, GLUCOSE-INSULIN, GLUCOSE/INSULIN) is an infusion which takes advantage of a side effect of insulin, the lowering of serum potassium. A mixture of regular insulin and 10% glucose is run, with rapid lowering of potassium. The order for the mixture must be entered as above rather than as two words.

Supplied: mixed when ordered.

Usual dose: no fixed dose. Just run it and watch the potassium.

Indications: severe hyperkalemia.

Actions: drives potassium into cells.

Precautions: may provoke hypoglycemia, may overshoot and cause abnormally low serum potassium.

SAMPLE ORDER:
INFUSE INSULIN-GLUCOSE MIXTURE
GLUCOSE/INSULIN BY PUMP

ISOPROTERENOL (ISUPREL) is a cardiac stimulant, somewhat similar to epinephrine. It raises the heart rate, reduces any conduction block, and increases the force of contraction. It has little effect on blood vessels. It causes a major increase in irritability and oxygen need.

Supplied: mixed as an infusion. Protocols vary, so order in mcg/kg/min.

Usual dose: start around .03 micrograms/kg/min, increase until effects are seen, avoid exceeding .3 mcg/kg/min.

Indications: second choice drug after atropine for refractory bradycardia, high degree AV block.

Actions: cardiac stimulant which affects primarily heart rate and conduction.

Precautions: may increase the size of an infarct. Increases probability of fibrillation.

SAMPLE ORDER:
ISUPREL DRIP

LIDOCAINE (XYLOCAINE) is a local anesthetic which is also useful in treating abnormal heart rhythms. Of course, if the patient is in V-fib or V-tach, a shock must still be given after the drug to restore a normal rhythm. Blood concentrations of lidocaine fall off over about 20 minutes, so a second bolus and/or an infusion is necessary. Lidocaine is also valuable in preventing abnormal rhythms before one has ever occurred. Many experts recommend giving lidocaine routinely to any patient who has had a heart attack. You will probably come out ahead in this simulation if you do so.

Supplied: AMPULE = 5 CC = 100 MG

Usual dose: adult--100 mg bolus followed by drip of 1 to 4 mg/min, repeat bolus 50 mg in 20 minutes. (If the patient is in trouble, don´t waste your "minute" starting the drip right after the bolus--do more important things, then remember to start the drip in a few minutes)

child--1 mg/kg bolus. Cardiac irritability in a child is almost always due to acidosis or electrolyte

abnormality, but if a drip is required, use .01 mg/kg/min, with a bolus of .5 mg/kg in 20 minutes.

Somewhat effective ENDOTRACHEALLY.

Indications: recurrent V-tach or V-fib. Second choice after Bretylium for resistant V-fib. Prevention of fibrillation in heart attack patients.

Actions: reduces risk of rhythm disturbance.

Precautions: excess doses can cause low blood pressure, seizures. Bolus will wear off unless followed by a drip.

SAMPLE ORDER:
LIDOCAINE 75 MG BOLUS
START LIDOCAINE DRIP

MORPHINE is a potent narcotic used to relieve the pain of a heart attack. It tends to lower the likelihood of fibrillation and reduce the ultimate amount of cardiac damage in an uncomplicated heart attack. It also lowers blood pressure, and therefore should not routinely be used in a patient in shock or post-cardiac arrest. By causing blood to pool in the veins, this blood pressure-lowering effect can be helpful if the patient is in pulmonary edema (lungs full of water because of a failing heart).

Supplied: order in MG

Usual dose: 6 to 10 MG for an adult, (start about .1 mg/kg for children) may be increased as necessary.

Indications: Pulmonary edema, pain of myocardial infarction.

Actions: Relaxes walls of blood vessels, lowering blood pressure, reducing the "work" of the heart, depresses the central nervous system.

Precautions: may cause shock in certain patients, may cause stupor or coma in high doses. Brain effects of morphine can be reversed with NARCAN.

NALOXONE (NARCAN) reverses the effects of narcotics, without any harmful effects of its own.

Supplied: regular--AMPULE = 1 CC = .4 MG
neonatal--AMPULE = 2 CC = .04 MG

Usual dose: adult or child--2 amps. If Darvon (propoxyphene) is suspected, up to 10 amps may be given.
infant--.01 mg/kg.

Indications: known narcotic overdose, any undiagnosed coma or delirium.

Actions: directly antagonizes narcotics.

Precautions: none.

SAMPLE ORDER:
NARCAN 2 AMPULES

POTASSIUM (KCL) is a body electrolyte. Severe lack of potassium can upset the heart's electrical system. Only when the potassium is causing rhythm disturbances should potassium be given by a fairly rapid IV infusion.

Supplied: mixed by nurse.

Usual dose: no more rapid than 1 MEQ per minute for an adult.

Indications: severe hypokalemia with impending rhythm disturbance.

Actions: raises blood potassium.

Precautions: may overshoot and cause hyperkalemia. Rapid injection can cause cardiac arrest.

SAMPLE ORDER:
POTASSIUM BY PUMP
KCL INFUSION

PROPRANOLOL (INDERAL) does the opposite of isoproterenol. It slows the heart, slightly increases conduction block, and decreases the force of contraction. It is almost never used in cardiac arrest. Its primary use is for lowering blood pressure and heart rate. It is sometimes helpful in controlling the rapid heart rate of atrial fibrillation.

Supplied: AMPULE = 1 CC = 1 MG

Usual dose: adult--1 mg repeated up to a total dose of 5 mg if necessary.
child--.01 mg/kg, repeated x 4 if required.

Indications: rapid lowering of blood pressure or heart rate. Second-line drug to control the rate in atrial fibrillation.

Actions: blocks stimulation of the heart, increases AV block.

Precautions: avoid if possible in cardiac arrest situations.

SAMPLE ORDER:
INDERAL 1 MG

SALINE (NS, N.S., RINGERS, RINGER´S) is a volume expander to increase blood volume. Although different in composition, saline and ringer´s are treated the same in this simulation.

Supplied: IV bottles, ordered as an infusion.

Usual dose: if the patient is truly volume depleted, with hypotension, a rate of 2000 to 4000 cc/hr (50-80 cc/kg/hr) until the blood pressure responds is not unreasonable.

Indications: initial support of hemorrhage with shock, hypovolemia due to fluid loss.

Actions: expands blood volume.

Precautions: excess fluids in a patient with a major heart attack can flood the lungs with water.

SAMPLE ORDER:
SALINE INFUSION
START IV NS

VERAPAMIL (CALAN, ISOPTIN) has complex actions. Its primary use is to treat abnormal, rapid atrial rhythms (such as paroxysmal atrial tachycardia). It decreases heart rate when in sinus rhythm, increases AV block, and may lower blood pressure somewhat. There is evidence that it may protect the heart and brain from oxygen lack. It is rarely used in a cardiac arrest situation.

Supplied:

Usual dose: adult--5 mg, repeated if no effect.

Indications: paroxysmal atrial tachycardia. Decreases the ventricular rate in atrial fibrillation.

Actions: increases AV block, decreases sinus rate, relaxes blood vessels.

Precautions: may predispose to bradycardia and hypotension. Absolutely not to be given with Propranolol.

SAMPLE ORDER:

VERAPAMIL 5 MG

A SIMPLIFIED APPROACH

↓

IF arrest was witnessed
AND rhythm is V-fib or V-tach
AND less than 2 min since arrest
THEN defibrillate at once

↓

IF arrest was unwitnessed
OR more than 2 min without any CPR
THEN give BICARB 2 AMP (1 MEQ/kg)

↓

UNTIL PULSE IS PRESENT:
Give EPI 1 AMP (.01 MG/kg = .1 CC/kg) every 5 min
Give BICARB 1 AMP (.5 MEQ/kg) every 10 min (adjust dose with ABG if possible)

↓

(V-tach, V-fib) TOO FAST ⟵ WHAT RHYTHM? ⟶ TOO SLOW (asystole, block, bradycardia)

(V-tach, V-fib) TOO FAST:

- DEFIB 200 JOULES (2-4/kg)
  DEFIB again
- ↓ Are EPI and BICARB adequate?
- ↓ BRETYLIUM 5 MG/kg
  (repeat if necessary)
- ↓ DEFIB
  DEFIB again
- ↓ LIDOCAINE 100 MG (1 MG/kg)
  if recurrent or still resistant
- ↓ DEFIB
  DEFIB
- ↓ Get ABG, LYTES, TEMP

WHAT RHYTHM? ↓

- GOOD BUT NO PULSE
- ↓ Are EPI and BICARB adequate?
- ↓ Get ABG, LYTES, TEMP
- ↓ ISUPREL DRIP (.03 mcg/kg/min)
  increase up to .2 mcg/kg/min
- ↓ ??CALCIUM 1 AMP (.1 CC/kg)
  (controversial)

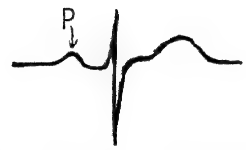
TOO SLOW (asystole, block, bradycardia):

- ATROPINE 1 AMP (.01 MG/kg)
  repeat
- ↓ Are EPI and BICARB adequate?
- ↓ ISUPREL DRIP (.03 mcg/kg/min)
  increase up to .2 mcg/kg/min
- ↓ Get ABG, LYTES, TEMP
- ↓ Try DEFIB
- ↓ ??CALCIUM 1 AMP (.1 CC/kg)
  (controversial)

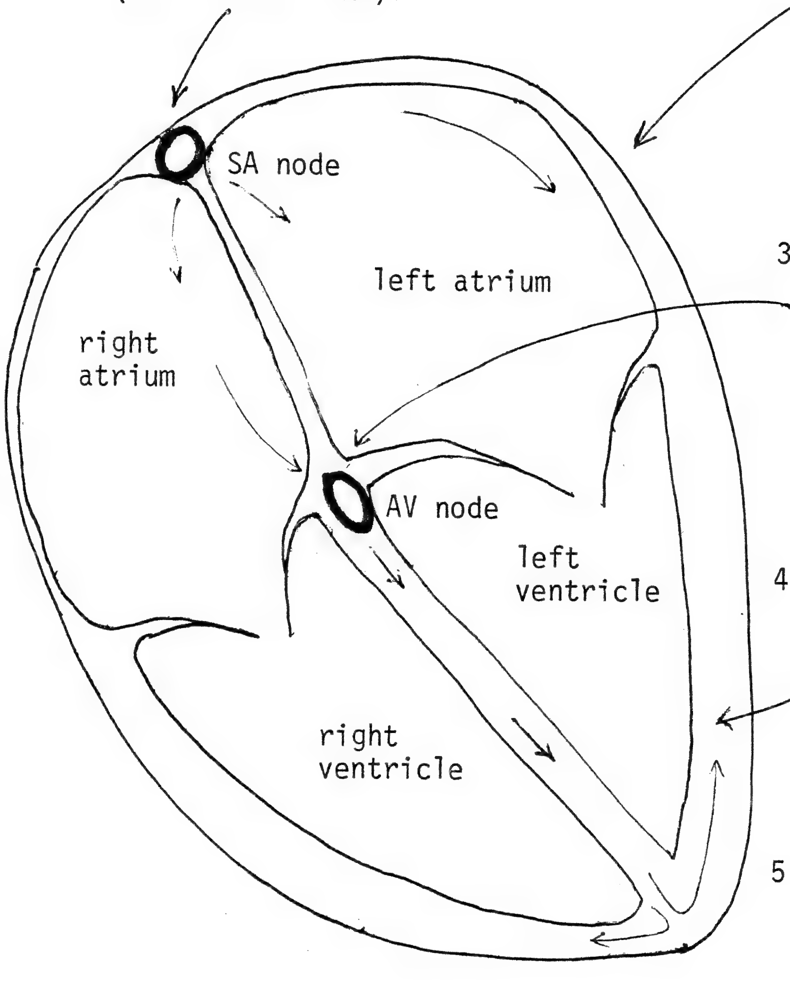
⟶ Keep trying, correct all problems

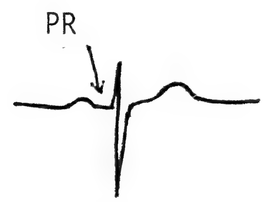
THE ELECTROCARDIOGRAM

1. Sinoatrial (SA) node fires (not seen on EKG).

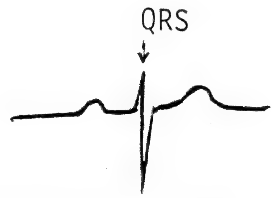


2. Impulse spreads over atrium (P wave).

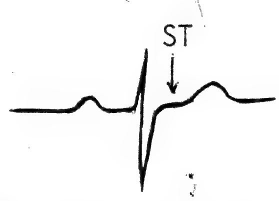




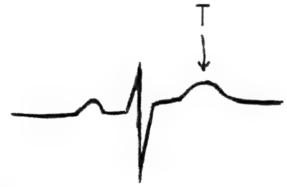
3. Impulse delayed in atrio-ventricular (AV) node (PR interval). Atrium contracts.



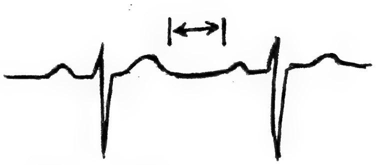
4. Impulse travels rapidly over ventricle (QRS complex).



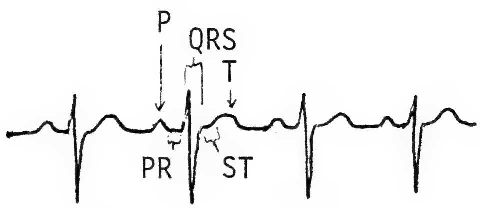
5. No current flowing unless heart is "malfunctioning" (ST interval). Ventricle contracts.



6. Heart "recharges" (T wave).

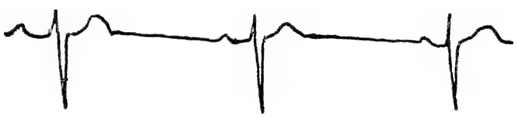


7. Heart rests.

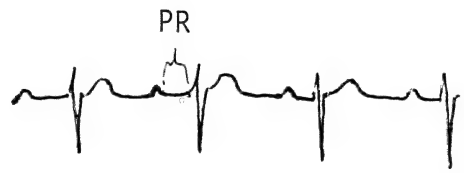


SINUS RHYTHM: Every QRS preceded by a P wave, rate 60 to 100

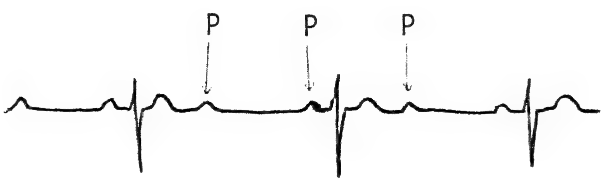
SINUS TACHYCARDIA: Every QRS preceded by a P wave, rate over 100.



SINUS BRADYCARDIA: P wave before every QRS, rate less than 60

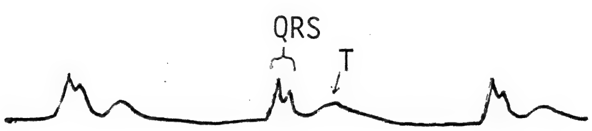


CONDUCTION BLOCK, first degree AV block: Every P wave conducted, but long PR interval.

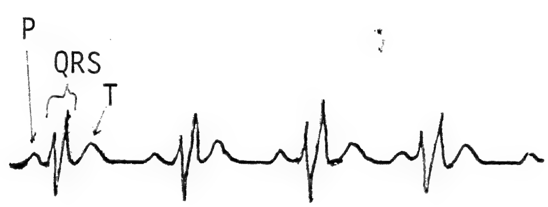


CONDUCTION BLOCK, second degree AV block: Every other P wave does not get down into the ventricle to cause a QRS.

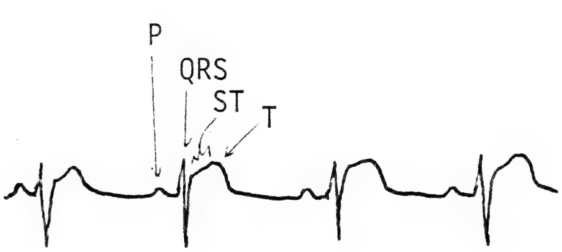
CONDUCTION BLOCK, third degree AV block: P waves have no relation to QRS (none conducted, ventricular rhythm)



VENTRICULAR RHYTHM: Rate is slow, no P waves are seen, QRS is wide.

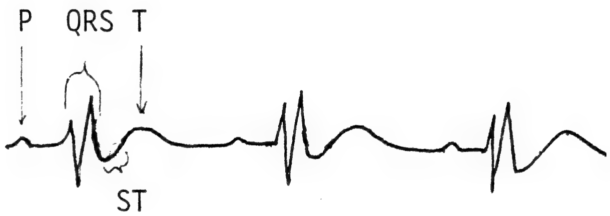


RIGHT BUNDLE BRANCH BLOCK: Part of ventricular conducting system blocked. Wide QRS with second upper peak.

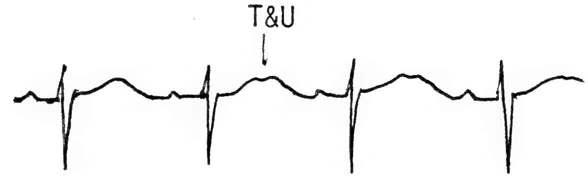


HEART ATTACK: Elevated ST segment.

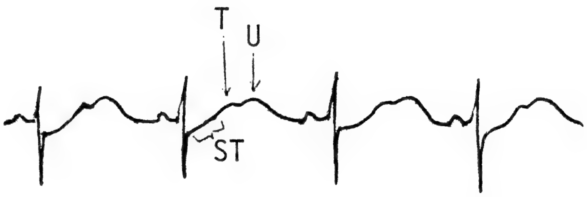
SEVERE HEART ATTACK: Wide lower part of QRS, possible loss of upper part of QRS, elevated ST segment.



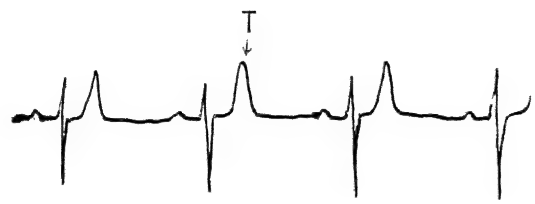
HYPOTHERMIA: All intervals prolonged, ST segment depressed. Often right bundle branch block.



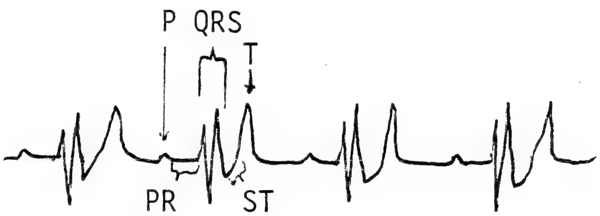
HYPOKALEMIA: Prolonged T, possible U



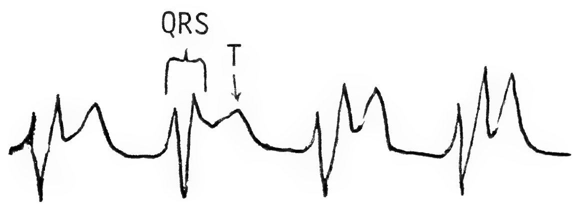
SEVERE HYPOKALEMIA: ST depression, prominent U wave, PR fairly short.



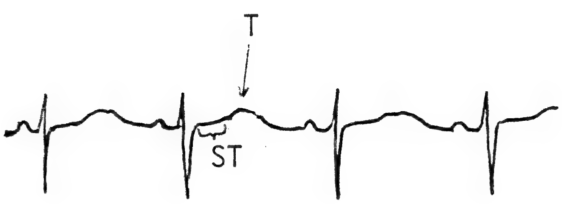
HYPERKALEMIA: Tall, peaked T



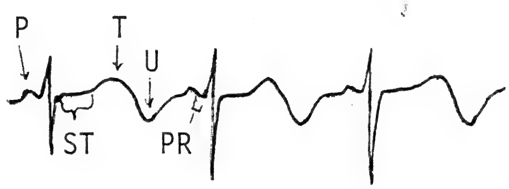
MODERATE HYPERKALEMIA: Long PR, wide QRS, ST depression, tall peaked T wave.



SEVERE HYPERKALEMIA: Disappearance of P wave, wider QRS, may slur into tall T wave.



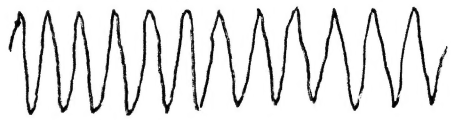
HYPOCALCEMIA: Short PR, prolonged ST, wide T, possible U wave.



SEVERE HYPOCALCEMIA: Shortened PR, prolonged ST, wide T, possible inverted U.

HYPERCALCEMIA: Short ST , short T

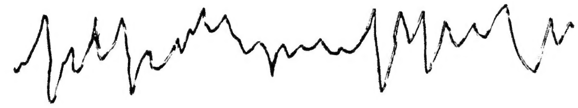
SEVERE HYPERCALCEMIA: Prolonged PR, short ST, short T. Often tachycardia.



VENTRICULAR TACHYCARDIA: Perfectly regular tachycardia, rate above 200, wide QRS.

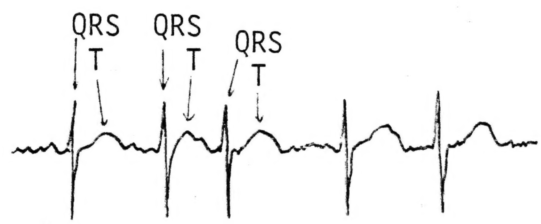
VENTRICULAR FIBRILLATION, fine: erratic, irregular "wiggling" EKG, with no QRS, no pulse.

ASYSTOLE: No electrical activity at all.



VENTRICULAR FIBRILLATION, course: Erratic, wide swings of electrical activity, irregular, no pulse.

AGONAL RHYTHM: Very slow, wide QRS complexes, without P waves, often without T waves. No pulse.



ATRIAL FIBRILLATION: Irregular QRS complexes, "wiggling" baseline, no P waves.

GLOSSARY

...a brief pronunciation guide so you won't sound like an idiot...

acidosis (ass-id-OH-siss), excess acid in body

agonal (A-gun-uhl), slow useless rhythm indicating a dying heart

alkalosis (al-ka-LOH-siss), excess bicarbonate in body

ampule (AM-pule), single-use container of drug, often a pre-filled syringe

anemia (uh-NEEM-ee-uh), deficient in blood or hemoglobin

asystole (ay-SISS-toll-ee), absense of electrical activity

atrial (AY-tree-uhl), pertaining to the upper heart chamber

atropine (A-troh-peen), cardiac drug

bicarb (BY-karb), short for bicarbonate

bicarbonate (by-CAR-bun-uht or by-CAR-bun-ATE), alkaline chemical in blood

bradycardia (brad-i-CAR-dee-uh or bray-dih-CAR-dee-uh), abnormally slow heart rhythm

bretylium (bre-TILL-ee-um), cardiac drug

CPR, cardio-pulmonary-resuscitation

calcium (KAL-see-um), chemical in blood and bones

cardiac (CAR-dee-ack), pertaining to the heart

cardiogenic (CAR-dee-oh-JENN-ik), caused by a heart condition

chloride (KLOR-ide), blood chemical

coma (KOH-muh), unconscious and not responding to pain

defibrillate (dee-FIB-rill-ate), shocking the heart to restore normal rhythm

dehydration (DEE-hy-DRAY-shun), body fluid deficit

dextrose (DEX-trohss), a type of sugar injected IV

diabetes (DIE-a-BEET-iss), abnormal sugar metabolism due to lack of insulin

diabetic (DIE-a-BET-ik), condition of, or person with, diabetes

diazoxide (dy-a-ZOX-ide), blood pressure drug

digoxin (di-JOX-in), cardiac drug

dobutamine (doh-BUTE-a-meen), cardiac stimulant drug

dopamine (DOH-puh-meen), cardiac stimulant and blood pressure drug

electrolytes (ee-LEKT-row-lights), chemicals (ions) in the blood

endotracheal (EN-doh-TRAY-kee-uhl), into the trachea

epi (EH-pee), short for epinephrine

epinephrine (e-pi-NEF-rin), cardiac stimulant drug

fibrillation (FIB-rill-AY-shun), erratic unorganized electrical activity

glucose (GLUE-kohss), blood sugar

hemoglobin (HEE-moh-glow-bin), pigment in blood which carries oxygen

hemolysis (hee-MAW-luh-siss), red blood cells bursting

hemorrhage (HEM-or-rij), bleeding

hypercalcemia (HY-per-kal-SEEM-ee-uh), excess calcium in blood

hyperglycemia (HY-per-GLY-SEEM-ee-uh), excess sugar (glucose) in blood

hyperkalemia (HY-per-kay-LEEM-ee-uh), excess potassium in blood

hypertension (HY-per-ten-shun), abnormally high blood pressure

hyperthermia (HY-per-THERM-ee-uh), body too hot, heatstroke

hypocalcemia (hy-POH-kal-SEEM-ee-uh), abnormally low calcium in blood

hypoglycemia (hy-POH-gly-SEEM-ee-uh), abnormally low blood sugar

hypokalemia (hy-POH-kay-LEEM-ee-uh), abnormally low blood potassium

hypotension (HY-poh-ten-shun), abnormally low blood pressure, shock

hypothermia (hy-po-THERM-ee-uh), low body temperature

hypoxemia (hy-pox-EEM-ee-uh), low blood oxygen

infarction (in-FARK-shun), death of tissue due to lack of oxygen

infusion (in-FUZJ-un), steady flow of drug into the patient

insulin (IN-suhl-in), sugar-lowering drug

intravenous (in-truh-VEE-nus), by vein

isoproterenol (IE-soh-proh-TER-en-awl), cardiac stimulant drug

ketoacidosis (KEE-toh-ASS-id-OH-siss), excess acid plus ketones, usually diabetes

kilogram (KILL-a-gram), 2.2 pounds

lavage (luh-VAWJ as in corsage or triage), flushing fluid in and out

lidocaine (LIE-doh-cane), cardiac irritability drug

milliequivalent (MILL-i-ee-QUIV-uh-lent), unit of ionic activity

milligram (MILL-i-gram), unit of weight, 1/1000 gram

milliliter (MILL-i-LEE-ter), unit of volume, 1 cc, 1/1000 liter

morphine (MORE-feen), narcotic

myocardial (my-oh-CARD-ee-uhl), pertaining to the heart muscle

naloxone (nal-OX-ohn), narcotic antidote

nasogastric (NAY-zoh-GAS-trick), through the nose into the stomach

neurological (NUHR-uh-LOJ-i-kuhl), pertaining to the brain or nervous system

potassium (poh-TASS-ee-um), blood chemical

propranolol (proh-PRAN-uh-loll), cardiac blocking drug

pulmonary (PULL-mun-air-ee), pertaining to the lungs

resuscitation (ree-suss-i-TAY-shun), efforts at restoring life

ringer's (RING-erz), altered salt solution to expand blood volume

saline (SAY-leen), salt solution to expand blood volume

sinus (SINE-us), referring to place where normal rhythm originates

tachycardia (tack-i-CAR-dee-uh), abnormally rapid heart rate

triage (TREE-awj as in corsage), deciding who needs treatment first

urea (you-REE-uh), chemical measured in BUN

ventricle (VENN-trick-uhl), lower heart chamber

ventricular (venn-TRICK-you-ler), pertaining to the lower heart chamber

verapamil (ver-AP-uh-mil), cardiac drug